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INDIVIDUALITY IN RESEARCH

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THE men of no other country have exhibited so great a measure of individuality in research as those of England. In the highest degree they have manifested the self-reliant strength of natural genius. Among them scientific endeavor has not been organized; and for the most part investigations have been carried out by single workers in isolation. British science has always refrained from congregating in distinct schools and institutions; it has never been localized in definite centers. No compact body of pupils there develops the work and ideas of any master. Thinkers proceed singly and individually with their self-appointed tasks laboring in close touch with nature and according to their particular inclinations.

These peculiarities of British science have always been in evidence from the earliest times through the central achievements of Newton and down to our own day. In illustration of the way of work of a scientist in England let us consider the contributions of Faraday, through whose labors the theory of electricity has been revolutionized. Guided by his own experimental researches, which resulted in the knowledge of many new facts and opened up problems of far-reaching importance, he developed his own mental construct or individual way of representing the phenomena to his thought which was so far different from that employed by others that only a few in a generation were able to follow him in the course of his reasoning. He pictured space in the neighborhood of an electric charge as filled with lines of electric force and through these lines found a means of penetrating to a deeper understanding of electric phenomena than any of his predecessors or contemporaries. By aid of an active imagination he was able to ascertain the nature of the interactions among electric charges, representing these to himself by means of geometric relations among his innumerable curved lines of force.

For a time it seemed to most interested persons that his processes were too loose to permit of confidence in his conclusions; though all admitted that they had led him into the most interesting and remarkable experimental researches. After the matter had lain for a time in this state in which the theoretical explanations had so large an element of individual bias in them that they could not be understood by most investigators, the entire theory was taken up anew by Maxwell in the light of Faraday's speculative discussions and reduced to a new mathematical form. In this way it finally became clear that Faraday's original conceptions had in them all the clarity of mathematical precision.

But it was the next generation after Faraday which first understood properly the range of his ideas. So is it likely to be ever with thinkers of the most marked individuality; so has it been preeminently among British scientists. As another example witness the case of Newton, whose work was first thoroughly appreciated by the following generation and in another country than his own.

In this respect the English are in most pronounced opposition to the Germans, while in some ways the French occupy the intermediate ground between them. Of these three countries which have led in scientific development it seems to be the impartial verdict of history that we owe to France the largest number of works perfect in form and substance and classical for all time; that the greatest bulk of scientific work, at least in more recent years, has been produced in Germany; but that the new ideas which have fructified science, in earlier times and also in the nineteenth century, have arisen more frequently in England than in any other country. In the second half of the nineteenth century the three leading ideas of science were probably the law of conservation of energy, Darwin's theory of descent, and Faraday's conception of electrical phenomena particularly in the more generally intelligible form which Maxwell gave to it. The latter two of these arose definitely in England; and the work of Joule on heat went a long way toward the fuller announcement of the first by Helmholtz. All three of them have been worked out with the definite cooperation of scientific investigators in all countries.

At the beginning of the nineteenth century the spirit of exact science, so far as it belonged to any large portion of the educated population, was domiciled in Paris. In such an atmosphere scientific writings took on the form of elegant literary productions. From Paris the spirit of interest spread into all countries and leavened the thought and literature of the whole world. In the country of its origin this elegant literature has maintained the traditions of its early development. In England it has been modified by the spirit which magnifies the individuality of each thinker. In Germany it has taken the direction indicated by the great organization of thought there. Most German investigators stand under the guidance of a few leading minds. Their contributions to thought fall, therefore, into a few important schools in which all their researches may be ordered.

To this general statement there is one marked exception. At least one of the great intellects of Germany worked in isolation very much like that which forms the rule in England; and it is worthy of note that he is without question the greatest man in his field produced in Germany and in every respect one of the foremost men of thought in the world. I refer to Gauss, the self-taught mathematician, a thinker whose work was not well understood and appreciated by his contemporaries. But the one notable exception leaves intact the general rule that the spirit of investigation in Germany has generally manifested itself in the labors of organized bodies of researchers.

The observation of such definite national differences, particularly that between England and Germany, brings forcibly to our attention the question as to the outward circumstances under which scientific investigation will flourish best, especially for extensive periods of time or in the long run. The two kinds of activity, that in which the workers are joined together in more or less compact bodies each of which is engaged in developing one general class of ideas and that in which the individual researchers labor in isolation pursuing separately their several inclinations, presumably have their characteristic advantages and defects. To know what these are is a matter of importance both to the nation and to the individual investigator.

Let us suppose that a particular science is in the situation of having its main general ideas already at hand and that it is confronted with their detailed development as the work next to be considered. It is clear that this is a situation in which organization of effort is going to count for efficiency. It is then relatively easy for a man of initiative to direct the researches of several less gifted collaborators. A number of investigators thus working together in unity instead of isolation afford much assistance and stimulation to each other and accomplish in a short time what otherwise would require a much longer period.

In a condition of this sort German science in recent years has been far more efficient than that of any other country, while of the four or five leading nations England has probably profited least by organization of effort. In British science generally we are struck by two things: the individual greatness of certain separate investigators, and the meager results achieved by all others. But in Germany we see everywhere the detailed development of particular theories and the accumulation of large masses of published results, greater in body than that produced in any other country, while in France and Italy and America we find a state of things intermediate between the extremes represented by Germany and England.

Organization of effort has advantages aptly illustrated by the achievements of German science. But there is at least a reasonable question whether it may not also have its drawbacks, whether there is not a measure or type of organization that hinders individuality and inhibits original ideas or points of view.

To some thinkers it has seemed that rare combinations of insight and perseverance and the skill to penetrate to the heart of nature are more likely to spring up among a people opposed to highly developed systems of thought and organizations of effort and given much to emphasizing the individual and his separate achievements. Such an idea seems to be borne out by the continued fruitfulness of England through many generations in the production of fundamental and guiding ideas in the development of science, particularly since she has in this respect apparently surpassed every other country.

Discoveries in England emanate most frequently from the depth of original genius in intimate communion with nature. Such a thinker is far enough separated from others to allow nature to work out her own impression upon him, so to speak, with less interference from the inertia due to fixed habits of thought and the preconceptions of contemporary science. There is no large university system in England eager to nurse and develop new talent and engulf all its energy into the common whirlpool; and English thinkers, therefore, in greater proportion than those of other countries, live in intimate communion with nature. They are thus the most likely of all to develop the new idea of fundamental importance.

Openness and plasticity of mind, even to age, is a general characteristic of men of genius. A desire for truth is their fundamental possession and they are not deterred from its pursuit by petty inconsistencies. Socrates was delighted when confuting others; and, if found in error, was no less pleased when confuted. In his mind no evil was so great as a false judgment concerning the just and the unjust.

Radical changes of opinion have not infrequently taken place in the gifted man late in life. At forty-seven years of age Dryden in 1678 produced "All for Love," writing the play for himself rather than for the public and basing it on a new dramatic theory which he had evolved during an interval of rest from writing. Cayley turned to the study of law at twenty-five and after entering upon its practice changed his field of activity to become one of the great mathematicians. Not till the age of forty-nine did Cowper find out that he could write, and then for a time produced volume after volume which his readers have learned to dwell on with affectionate appreciation.

In genius there is nothing static. In every aspect it is dynamic. Thought is not fixed; it is in constant ebb and flow. Everything is afloat and no conservatism is safe. The talk of a man true to his individuality tears from its moorings all thought among his associates. However well things may have been set up before he speaks, they need to be set up again afterwards.

Truth-bearing ships may not rest at anchor where a genius is present; they must go forth upon voyages to the outermost bounds of thought. Inoculated with the ferment of his mind, they will deliver new and powerful knowledge in the remote regions, kindling everywhere a fresh illumination of beauty. In their moving hither and thither will be much profit of valuable exchange. The bread of life shall they bear to the needy, and return the wine of new truth to the out-sender.

In a few individual cases genius has seemed to be almost universal. Aristotle was learned in all the lore of his time and made fundamental contributions to thought in many directions. Poincaré was a leading investigator in every division of mathematics at a time when the subject was generally esteemed so vast and diverse in its parts that no man could be properly acquainted with all of its essential developments.

At the opposite extreme there have been men of high achievement in a narrow channel of activity whose work was magnificent in its proper region, but out of it was stupid. With the heroic meter Pope was a dexterous genius, but outside of his habitual forms he was helpless and indeed even insensible of his incapacity.

Among men of research this is the day of narrow specialization. Numerous workers achieve notable advancement in a narrow field and yet are not broad enough in view to estimate properly the bearings of their own results. They can do a work of value only because a greater mind has dealt with the whole problem and has made apparent the need of development in certain phases. Research will never be able to dispense with the man of wide outlook who must do the fundamental work in the advancement of knowledge.

In the earlier days much of the activity of genius was demanded for war and government. The Roman temple of Janus, which was open during war and closed during peace, was shut only four times before the Christian era. But war with occasional peace among the ancients has given place among the moderns to peace with occasional war. For a generation prior to the Great War in Europe the activity of genius had been largely liberated for use in science. Coincident with this liberation was the most wonderful development of knowledge yet witnessed in the world. Man obtained a greatly increased control over nature and her forces; and the rapidity with which he extended his conquests far exceeded the highest expectations. Let society release anew her men of genius to pursue undisturbed each the matter of his own delights; and they will soon come again bearing the booty of peace and the rewards of thought, enriching life with enduring conquests of surprising grandeur.

Only one other period in the history of the world can be compared in its enormous advances in thought with the period of the present, namely, the age of Pericles in ancient Greece. The earlier period was characterized by the astonishing concentration of the wonderful development in the single city of Athens; the later period by the widespread advances in both Europe and America, depending on a collaboration of effort and unity of interest not before manifested in the history of thought. But these two developments, widely separated as they are in time and springing up under different world conditions, have this common element that they arose during a period of peace when genius was released from the concerns of war and was free to pursue its own more congenial interests.

Within the last one hundred years scientific research has opened up many new types of problems. It has found out how to reach with observation and measurement large classes of phenomena more intricate than any which were witnessed or even suspected in earlier times. It has sought by new methods the more hidden forces and conditions which make up and govern our everyday life. It can hardly be supposed that the science of one or two generations has found the best interpretation or explanation of all these facts, especially since relatively so few persons have been able to live in intimate daily communion with these novel and till recently hidden aspects of nature.

It seems therefore that this is an age which, while not neglecting the development of detailed results, is peculiarly one that should look with favor upon deep individuality and the consecration of the man possessing it to a life of intimate and daily communion with phenomena—a communion in which, as far as possible, he shall let nature speak her own language to him in her simplicity and unimpeded by the foreign accent and construction of our scientific jargon. It appears that in this way one has the best expectation of coming to a new and more penetrating vision.

In order that our research into nature shall be most effective in the long run it seems therefore to be a matter of the highest concern to keep unimpaired the deep individuality of those who live much alone with the intricate phenomena of the new nature revealed to us by contemporary observation. The continual presence of such spirits upon the planet affords the highest blessing which it can receive.

This interaction of individuality and organization presents a threefold aspect, appearing in its relation to the whole world of thought, to the activity of a single nation, and to the plans and purposes of the individual. Perhaps the problem for the world at large is best solved by that partial national division of labor which has existed heretofore and which is exhibited in a most marked manner by the contrasts of German and English scientific work. To the individual, particularly to the young researcher just finding himself and his most suitable field of interest, the problem appears in a somewhat different light.

For him the question often presents itself in this way: In a range of ideas already marked by the individuality of another and being worked out in detail from a well-defined point of view he sees a number of problems which interest him and into the solution of which he could go with zest and enthusiasm; but he sees that, for the present at least, this would be to merge his individuality in that of his predecessor. On the other hand, he may see or may desire to seek less well-defined fields of investigation which are awaiting the impress of a new individuality to bring to life their dormant possibilities. Into one of these he may enter and reduce to order, slowly at first and more rapidly afterwards, the chaos which he finds there. The first procedure will usually bring him into earlier notice; for among those ideas which are well-defined and those problems which are clearly set he will the more readily penetrate beyond the boundaries of present knowledge. But if he starts in the latter direction, though he may move things less promptly he will push them much further if he succeeds at all in getting them effectively into motion.

The more a domain demands originality for its exploration, the fewer are those individuals whose courage and persistence will enable them to penetrate it. It is better for a man to do the smaller work well than to fail entirely at the larger; but it is a more profound tragedy if the man of higher force does not find himself and therefore never applies himself to the greater problems which he might solve.

Thus the young researcher is confronted with a situation potent in its influence upon his life and the value to mankind of his labors; and between the two possibilities he must choose, either consciously and with foresight or unconsciously under the force of circumstances. Let him remember that the choice is to be made in the light of the character of service which his life devotion to constructive thought is to render in the progress of mankind.

The work of highest value can be done only as an expression of the most marked individuality. Let the beginner keep this ever before him as a fundamental principle. If his achievement is to have any first-rate qualities it must be through his allowing nature to write herself into his thought unimpeded by preconception, however hidden. The Universe honors nothing so much as the man who stands on his feet without the prop of contemporary or predecessor; and to no one else are her secrets so readily revealed. Every young researcher must choose for himself whether he shall stand in the place to receive this greater illumination or enter upon the less inspiring labor of developing already existent ideas.

The man of highest genius respects his work and does it nobly not only because it is of great value to mankind but also for a reason more important to him individually, namely, that it is an expression of himself and a means of developing him into that which he should become. He does not compare it with that of others as to value. It is a thing to stand alone and be judged of itself. With him is no concern for greater or less of genuine achievement. A realization of the best that is in him is all that he can accomplish; and he is unwilling to do what is less or different. The past and the distant, the near and the contemporary, delight him as commentaries on his own experience; but for himself he seeks primarily the noblest self-expression, whether in the production of art or in the creation of scientific truth. When a country does not find its ideals at home but draws them from abroad, it builds nothing worthy of admiration or study. When an institution, as of learning, looks elsewhere for its inspiration and not to its own men and environment, it is dead and can not lead or inspire in the way of knowledge. When an individual draws his problem from another individual he has already made himself of second rate or lower in research. But when a man takes up a problem that appeals to him or an institution plans a work which grows out of its place in its environment or a country according to its circumstances builds up what interests its own people, each does a work of fundamental import and becomes a source of instruction and inspiration to mankind.

The greatest need of every generation in science is the man who knows current theories and tendencies and yet thinks from a center of his own, the course of whose activity is spontaneous and free as the flow of a rivulet, adjusting itself with as little effort to the inhibiting bounds of his environment. He is the perennial fountain of life and power. Primarily he is concerned not with the impressions which things make on the minds of other men, but with what they make on his own. He gives place to the opinions of others only as a sort of commentary on his own thought, as the scholar's annotations are intended to elucidate the meaning of the master in the text. His business is not to declaim on the beauties which others have attained to, but to find a new and deeper beauty underlying them, to come a little nearer to the marvelous processes of nature.

Every one transfers something of himself into his perception of the matter. If he should give an accurate account even of his most unbiased observation he would not say, It was so and so; but, rather, Thus it appeared to me. However fully preconceptions and prejudices are laid aside, there is one thing unrelated to the event which the observer can not put away, namely, the observer himself. If one is sincere and thinks from a center of his own, everything will take somewhat the color of the beholding eye, just as the world appears red when seen through red glasses.

It is impossible for one to come to the study of any class of phenomena or range of ideas without bringing his past experience and the inertia of his previous way of looking at things. Even natural science has found no way to avoid this. At best one can only reduce to a minimum the influence of prejudice and the inertia of preconception.

This obtrusion of the individual into every result of observation and thought has the most intimate connection with the meaning which should be attached to scientific truth and research. The characteristics of human thought and human sense impressions determine science quite as much as the external phenomena which are being studied. We possess a small number of special senses quite limited in the range of *quality* of impressions which they can give to us. Any particular one of these special sense organs, whatever the source of the stimulus, gives to us the same quality of sensation. Through the optic nerve, for instance, however it may be excited, we receive only sensations of light. Now it can hardly be supposed that nature possesses just a few qualities and those alone which we are able to perceive. Moreover, we know definitely that a single sense can not distinguish in many cases between phenomena of the most diverse kinds. Is it not then reasonable to conceive the possibility that phenomena in general exhibit many aspects, intrinsically very different, which we are not in the least able to distinguish even with the use of all our special senses? If this be true our science must in the end be very remote from the actually existent phenomena which we seek to explain. In other words, all our scientific hypotheses must be shot through in all directions by the peculiarities of the mental constitution of those who build up this science. Thus the latter is deeply colored not merely by individual, but by racial characteristics.

In all this is no cause for regret. We build our science for its value to us in ways both utilitarian and esthetic. For this it is quite sufficient for us to ascertain merely the invariant and permanent elements of the impressions made by phenomena upon the total human organism. Our progress will be greatest when we come in our explanations as closely as possible to the way in which the new phenomena would impress one who suffered least from the inertia of preconception. In other words, our progress will be most fundamental, other things being equal, when many individual researchers are moved primarily by that interest which springs from deep individuality. In this way we will have most consistent attention to the problems which lie closest to hand.

To consider first and primarily the problem nearest to hand is a concern not merely of the individual. In our country, particularly, scientific investigation carried on largely by groups of men connected with the institutions as such should develop in some measure the matters which are suggested naturally by their relations to the varying bodies of supporters. In like manner the country as a whole should find some problems of central importance pertaining to the national life and thought in a way not in evidence elsewhere.

In the state university particularly we should find a zeal for research pertaining directly to the interests of the commonwealth supporting it. This should not take a too narrow form and would lose ultimately if it did; but it might well be adapted in a broad way to the demands of local interest.

This, however, could not affect all departments of thought; for some are essentially universal and non-local in character. Moreover, it should not be allowed to dominate all elements of thought in any department. This would be a narrowness fatal to the best interests. But in every department of most institutions (if not all) it is probably desirable to bring about the development of a local atmosphere, so to speak, favorable to concentrated effort along certain lines, but of course not antagonistic to any general trend of progress. No department in any one university can well represent every phase of the development of its subject; but it can represent a proper variety and at the same time a certain measure of continuity and deep relation of the particular fields primarily developed by it. In some cases at present our institutions are losing by too much separateness of effort in a particular environment, sometimes going so far that creative men in the same department are unable to understand the character of work produced by each other. It seems that such a situation as this should exist only in very rare cases, if at all. A greater solidarity of effort would doubtless further both the ends for which the department exists, namely, the creation of truth and the dissemination of truth.

The greatest example in history of a nation which set itself to work on the problems arising spontaneously out of its own interest is afforded by the city-state of Athens in the fifth century before Christ. Here, to begin with, the people built up a form of government which did not copy the laws of any neighbor. They thought things out for themselves from their own point of view and were most pleased perhaps when their speculations resulted in conclusions contrary to those previously reached. There was a marvelous openness to new truth. Strangers might come into the city at will, teaching whatever doctrine they would and carrying away with them the new truth gathered from the thinkers of the city. The Greek was calculating in preparation, daring in deed, and untrammeled by preconception when his logic led him to new or strange conclusions.

Through Pericles they said of themselves, " We are not angry with our neighbor if he does anything to please himself." On the other hand, it was expected that each would work out his own pleasure and contribute to the general good by whatever means pleased him best. He should be spontaneous and give an expression of himself in all things that he did. Under such circumstances in one century the city of Athens "gave birth to more great men of the first rank than the whole world has ever produced in any equal period of time."

Great achievement is intimately bound up with spontaneity of interest and effort. Science truly is international and profits much by the interaction of one people with another, even to the extent of obtaining fundamental values in this way. But the primary need is that each nation shall set about its part of the common problem in a way of its own, allowing its national individuality full freedom for self-expression according to its peculiar bias. Otherwise its attainments are a mere appendage to those of another people and contribute but little to the general good which would not have been as well developed if that nation had never existed. And so it has come about justly that history has recorded permanently but little concerning any civilization which did not develop from within. Likewise no national contributions to science can be of great and abiding interest unless they spring up essentially from the life and thought of the nation itself.

In order that we may have the greatest development with the most important consequences we must have abiding with us in research the spontaneity of the nation, the institution and the individual; and the greatest of these is the spontaneity of the individual.